marbles to hen's eggs, and fell in such quantities that, at some points of the storm path, on the following morning, they were gathered to the depth of two feet, and again, even as late as noon, some portions of the wagon roads were covered with a "perfect bedding of hail-stones." The loss to the farming community is estimated at $30,000. No such storm has ever visited this section since 1833, when the hail was about as large, and the path identical. Hadley, Me., 21st, most violent and destructive storm within the memory of the oldest inhabitant; all glass on the north sides of buildings, where not protected, was broken; Tobacco and corn crops a total loss; trees were stripped of their foliage, and, in some instances, those having a diameter of about one foot, were twisted or broken off: dead birds were found under almost every tree. Sparta, Ky., 21st, hail-stones size of hen's eggs, causing great damage to fruit and corn. St. John, N. B., 21st, great damage to crops in parts of Kent county, particularly in the parishes of Richibucto and Welford. Hadlyme, Conn., 21st, most violent since July 28th, 1838, when half the windows in the town were destroyed, and much other damage done. Hail-stones size of large walnuts; the damage to farming industries will reach many thousand dollars.

RELATIVE HUMIDITY.

The percentage of mean relative humidity for the month ranges as follows: New England, from 68 to 90; Middle Atlantic states, 56 to 81; South Atlantic states, 53 to 82; East Gulf states, 68 to 76; West Gulf states 56 to 77; Ohio valley and Tennessee, 58 to 76; Lower Lake region, 64 to 72; Upper Lake region, 63 to 74; Upper Mississippi valley, 61 to 75; Missouri valley, 64 to 74; Red River of the North valley, 59 to 73; Texas, 52 to 62; Middle Plateau, 30 to 42; Southern Plateau, 43 to 61; California, 33 to 77; Oregon, 46 to 64; Washington Territory, (Olympia,) 71. *High stations* report the following percentages not corrected for altitudes: Pike's Peak, 69.0; Santa Fé, 55.0; Cheyenne, 55.8; Denver, 47.6; Mt. Washington, 81.8.

WINDS.

The prevailing winds during the month of July, 1881, at Signal Service stations, are shown on chart No. II by arrows, which fly with the wind. Between the 82d and 92d meridians, *westerly*. Along the South Atlantic coast, *southeast*, and on the Middle Atlantic and New England coasts, *southwest* to *northwest*. In the Western Gulf states and Missouri valley, *east* and *south*. Over Texas and the eastern Rocky Mountain slope, *south* and *southeast*. In the Plateau regions, *southerly*, and along the Pacific coast, *westerly*.

Total Movements of the Air.—The following are the largest total movements at the Signal Service stations: Mt. Washington, 14,442; North Platte, 11,319: Hatteras, 10,543; Portsmouth, N. C., 10,175; Moorhead, 9,657; Chincoteague, 9,434; San Francisco, 9,384; Kittyhawk, 9,082; Ft. Sill, 8,904. The *smallest* are: La Mesilla, 1,406; Silver City, 1,910; Phœnix, 1,989; Memphis, 2,063; Florence, 2,351; Lynchburg, 2,526; Uvalde, 2,596; Springfield, Mass., 2,641; Roseburg, 2,688; Lewiston, 2,709; Nashville, 2,721; Augusta, 2,728; Fredericksburg, 2,837; San Antonio, 2,850; Morgantown, 2,855; Tucson, 2,861.

High Winds.—Winds of 50 miles per hour and over were reported as follows: On summit of Mt. Washington, 13th, 14th, 16th; maximum velocity, 60 miles, NW., 13th. On summit of Pike's Peak no high winds were reported during the month, the maximum, 40, SW., occured on the 10th. Sandusky, 56, NW., 12th. Cape May, 60, SW., 14th. Kittyhawk, 60, N., 7th.

Local Storms.—Few storms of this character have occurred during the month, at least those particularly destructive, and, except the violent tornado at New Ulm, Minn., none accompanied with any unusual demonstration of force or attended with great loss of life and property have been reported. On the afternoon of the 15th, the terrible tornado which visited portions of southern Minnesota, appeared first as a violent northwest storm over the western portion of the state and eastern Dakota, in the vicinity of Big Stone and Traverse Lakes. With increasing energy the storm traveled southeasterly down the valley of the Minnesota river, desolating portions of the following counties: Big Stone, Lac Qui Parle, Swift, Chippewa, Renville, Sibley, Brown, Nicollet and Blue Earth. The general atmospheric conditions preceding and accompanying the formation of this storm, are given as follows: Since the 10th there had prevailed, with remarkable persistance, an area of comparatively low pressure over the western portions of Iowa and Minnesota, and the eastern portions of Nebraska and Dakota. There was considerable variability in the barometric readings within the area of low during this period, ranging, as they did, from 29.65 to 29.96. At midnight of the 10th, the winds, throughout the four states above mentioned, were from N. to E., with temperatures ranging from 57° to 74°. On the following morning, with the advent from Saskatchewan valley of an area of low pressure, the barometer fell from 0.03 to 0.18 inch below the normal, followed over Iowa and Nebraska by a veering of winds to the SE., occasional light rains and slowly rising temperature. Eliminating the element of diurnal change, there was noted the steady advance northward of a high thermal belt, coupled with the significant constancy of southerly winds south of parallel 45° and of W. to NW. winds to the northward as far as Manitoba. These conditions continuing unabated, there appeared on the afternoon of the 15th

a belt of high temperatures, ranging from 90° to 100°, extending from eastern Iowa westward to eastern Wyoming and Colorado. Over northern Minnesota and Dakota the temperature ranged from 70° to 85° with W. to NW. winds, presenting, in the extreme, a thermal range of 30° between the opposing northerly and southerly movements of the atmosphere. Here was abundant evidence of a very powerful concomitant in the event of sudden and violent displacements of atmospheric equilibrium. Throughout western Dakota on the 15th, thunder-storms occurred at at various points and with considerable severity. Returning to the supposed region of commencement, we find the first evidence of destructive force manifested at the town of Odessa, on the Hastings and Dakota Railroad, where four buildings were demolished. Passing thence southeastward the storm swept the sparsely settled country for a width of from one to two miles, destroying farm houses, barns, farm machinery and killing horses, hogs and cattle. At the town of Fairfield, Mayer township, Swift county, nearly every building was blown to pieces, four persons killed and fifteen wounded. Outside of the town farm houses, in the track of the storm, were destroyed to the number of nine, their contents and the broken timbers were scattered over the ground for hundreds of yards. The bridge over the Pomme de Terre river was lifted from its foundation, turned over and carried four rods down the river. At Bird Island, Renville county, several houses were blown down and others unroofed, but no lives lost; the most violent portion of the storm lay further to the southwest. At Cairo, the storm was more violent; one building was lifted bodily into the air and blown to pieces; great damage was done to other buildings; five persons badly injured. In the town of Wellington, three persons were killed and several wounded; six buildings destroyed; hogs, horses and cattle killed, several animals having pieces of timber driven through their bodies by the force of the wind; one piece of scantling was found driven into the ground a distance of four feet. At West Newton five persons were killed and twelve wounded: fifteen buildings were either demolished or unroofed: a piece of 40 acres of timber was nearly leveled with the ground; hardly a single tree was to be found in an upright position. At Severance, in the southwest part of Sibley county the destruction in town and surrounding country was very great. At Milford, in the northwestern portion of Brown county, twelve or fifteen buildings were destroyed and six persons badly injured. We now reach the town of New Ulm where the storm culminated its energy and the violence of its destructive power. The day had been exceedingly oppressive with a gentle southesterly breeze, and at 3.30 P. M. a heavy thunder-storm appeared in the northwest, followed in about 20 minutes by the sudden rising in the southwest of a dark and portentous cloud. These two clouds advanced towards each other, their line of march intersecting at what appeared to be a point about three miles west of the town. Before the meeting the first strong wind came from the northeast, which continued about ten minutes, during which it rained considerably. At the meeting there appeared to be a terrific contest as to which cloud should have the right of way, and when this seemed to be fully decided the clouds apparently came to the ground, the lower portion having a tendency to elongate and form a spout-like protuberance. Shortly after this action, there appeared to persons observing the phenomenon at some distance from the storm centre, the formation of four large spouts running downward to the earth; sometimes they touched it and again would be drawn suddenly upward to the sky. These spouts were reported as of various shapes: one in the form of an immense inverted cone; another cylindrical; a third like a huge gourd, and another oblong with convoluted edges. They moved along with a swiftly revolving motion from right to left, and their path of destruction was about a mile and a half wide. At 4.45 p. m., (some give it 4.40 and 4.48 p. m.,) the tornado entered the town where it remained but 10 or 12 minutes, during which time 47 buildings were blown to atoms, and about 200 either unroofed or otherwise demolished; 6 persons were killed, 53 wounded, and 102 families rendered homeless. The loss to property in the town alone is variously estimated at from $300,000 to $500,000. The general direction of the *debris* as carried by the wind; particularly in the case of trees, appeared to be to the northeast and northwest, although there were many instances where they pointed to the south and southeast. The boundary lines of destruction were very closely defined, small frame buildings standing near solid brick structures were unharmed, while the latter were leveled to the ground. Several persons variously estimated the velocity of the wind at from 90 to 115 miles per hour. As the storm left New Ulm and passed to the southeastward, it visited the country in the vicinity of Butternut Valley and Cottonwood Creek, where several building were unroofed and considerable stock killed. At 6 p. m., the storm passed over Blue Earth county, about eight miles north of Winnebago City and disappeared at a point about two miles to the northeastward. For a distance of about ten miles, the destruction to crops and buildings, and the loss of stock was very severe, but the storms path had narrowed considerably at this portion of its course, being now from a quarter to a half mile in width, with considerably diminished energy. Boys Lake, Redwood Co., Minn., 16th, a small tornado with funnel-shaped cloud destroyed a farm house, stable and small outbuildings, leaving hardly a vestige of them near their foundations. A small pond in the track of the cloud was sucked dry, the water being carried over the adjoining fields, together with a large quantity of soft mud which was scattered over the ground for half a mile around. Mulligan, Cottonwood Co., Minn., 16th, during the afternoon a violent wind storm passed over this section destroying nearly every movable object in its course: several buildings were blown to pieces and

others unroofed; the damage to crops was very severe. Farther eastward the storm was reported as exceedingly violent. Mallory Lake, Hillsdale Co., Mich., 12th, 3.30 p. m., two and a half miles southeast of station, violent southwest storm unroofing and destroying buildings, leveling fields of oats and corn, demolishing fences and uprooting forest and fruit trees; occasional gaps intervened where the force of the wind seemed to raise for a short distance above the earth, and then return to it with renewed destructive energy. At Dover, fences were blown down, wheat shocks scattered over the fields and oats and corn badly damaged. Near Osseo several farm buildings were blown down, fences demolished and trees uprooted; in Wheatland and Palmyra townships much damage to crops. Brooklyn, N. Y., 13th, 4 to 4.25 p. m., trees, chimneys and small outbuildings blown down, and in several cases large buildings unroofed; in northern New Jersey and on Staten Island, the violence of the wind was very marked, trees were uprooted and many buildings blown down or unroofed. Cornish, Me., 16th, 4.30 p. m., violent wind storm or whirlwind passing from SW. to NE., moved over the adjoining country: width of path, about 50 rods and length about five miles; one large building, 70 x 15 feet, directly in the path of the storm-cloud was blown to pieces, carrying the *debris* several hundred yards: many other buildings were more or less damaged and orchards suffered severely; in passing over a cemetery, which chanced to be in the storm's path three large stones, 20 inches in diameter and several feet in height were broken off by the violence of the wind; some hail accompanied the storm, but did no damage; the storm-cloud, after crossing the Ossipee river, appeared to rise from the earth, when further evidence of its existence vanished. Fosteria, Ohio, 7th, during night, most violent windstorm for years; many buildings, among the largest in town, were unroofed and several blown down; in the country very disastrous effects were produced upon standing crops. Off Reedy Island, near Ft. Delaware, Delaware river, 7th, 7 p. m., terrific wind storm, lasting about 40 minutes: storm passed from SW. to NE. and the rain fell in torrents for about ten minutes: British bark "Beatrice" was struck by lightning and burned to the water's edge; the captain of an ocean steamer who passed through the storm stated that it was the most terrible he had witnessed in 20 years: it was short but exceedingly furious. Perry Valley, Iowa, 7th, violent wind storm passed over this region destroying several farm houses and the highway bridge over Perry's Creek. Rensselaer county, N. Y., 26th, violent wind storm swept over the county in the vicinity of Troy, demolishing buildings, uprooting trees and severely damaging crops. Ft. Supply, Ind. Ty., 22nd, 10.30 p. m., wind blew from the northwest at the rate of 30 to 60 miles per hour: but little damage was committed, owing to the sheltered position of the town. In northern Kentucky, southern Ohio and Indiana, violent wind and rain storms, causing great damage to crops and buildings were experienced on the 21st. Americus, Ga., 18th, at some distance from the town a small whirlwind, about 5 feet in diameter and sometimes 100 feet high, formed over a corn-field where it tore up the stalks by the roots and carried them with sand and other loose materials high into the air. The body of the whirling mass was of vaporous formation and perfectly black, the centre apparently illuminated by fire and emitting a strange "sulphurous vapor" that could be distinguished a distance of about 300 yards, burning and sickening all who approached close enough to breath it. Occasionally the cloud would divide into three minor ones, and as they came together again there would be a loud crash, accompanied by cracking sounds, when the whole mass would shoot upwards into the heavens. New Jefferson, Harrison, Co., Ohio, 16th, one church, many barns, stables and other buildings were blown down: about 20 horses were killed by the falling of stables: much damage to crops and fences in surrounding country. Atlanta, Ga., 12th, 5 p. m., terrific wind storm from the northwest, continuing for 30 minutes; the heavens were of inky blackness, which with the fury of the wind, made an appalling sight; considerable damage was done to fences, trees and outbuildings. Winona, Wis., 11th, 5 p. m., the car shops of the Winona and St. Peter railroad, 40x150 feet, were completely demolished; the air was filled with boards and other *debris* during the passage of the storm; several other buildings were badly damaged. Ft. Wayne, Ind., 12th, 5 p. m., unroofing houses, destroying shade trees and fences and severely damaging crops. Danville, Va., 8th, 5 p. m., buildings unroofed and blown down and considerable destruction to fences, trees and crops. Dallas, Tex., 1st, during night, fearful storm of wind and rain, fences, outbuildings, six residences and one church were demolished.

VERIFICATIONS.

Indications.—The detailed comparison of the tri-daily indications for July, 1881, with the telegraphic reports for the succeeding twenty-four hours, shows the general average percentage to be 87.57 per cent. The percentages for the four elements are: Weather, 93.6; Direction of the Wind, 83.1; Temperature, 87.3; Barometer, 86.3. By geographical districts they are: For New England, 86.9; Middle states, 82.6; South Atlantic states, 87.9; Eastern Gulf states, 91.4; Western Gulf states, 92.2; Lower Lake region, 86.0; Upper Lake region, 86.6; Tennessee and the Ohio valley, 90.8; Upper Missouri valley, 86.1; Lower Missouri valley, 84.3; Northern Pacific coast region, 98.3; Central Pacific coast region, 100.0; Southern Pacific coast region, 100.0. There were 82 omissions to predict (46 being due to the absence of reports from the Pacific coast), out of 3,813, or 2.15 per cent. Of the 3,731 predictions that have been made, 84, or 2.26 per cent are considered to have entirely failed; 140, or 3.75 per cent. were one-fourth verified; 376, or 10.07